DOCUMENT RESUME

ED 183 243 PS 011 061

AUTHOR Brooks, Rick
TITLE Brain Lateralization in Infancy: Implications for Development.
PUB DATE 79
NOTE 14p.

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Cerebral Dominance; Child Development; *Infants; *Neonates; Neurological Organization; Physiology; *Stimuli
IDENTIFIERS Responses

ABSTRACT

Evidence that hemispheric asymmetry is present at birth comes from several sources: physical structure of the brain, hand preference, and responses to visual and auditory stimuli. In infancy, a hemisphere is activated only when exposed to an appropriate stimulus. Different stimuli seem to activate one hemisphere only, or at least one hemisphere more than the other. This is very important in infancy because the corpus callosum, the neural fibers connecting the hemispheres, are structurally and functionally incomplete until around two years of age. Optimum brain functioning is the result of the development and efficient use of both hemispheres and an interhemispheric communication system. This hemispheric symmetry which may begin in infancy has been credited with optimal cognitive functioning. Although little is known about the relationship between types of stimuli and hemispheric activation, the message at this point would seem to be that infants need to be exposed to as wide a variety of stimuli as possible in order to activate both sides of the brain. (Author/MS)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED183243

Ps

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

Brain Lateralization in Infancy: Implications for Development

Rick Brooks

University of the South Pacific

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Richard L. Brooks
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

PS 011061

Running Head: Brain Lateralization in Infancy

Abstract

We now know that most adult brains have two very differently functioning hemispheres. Evidence seems to indicate that this develops as the result of an innate predisposition towards lateralization of cognitive functions. This idea is supported by many sources of information indicating asymmetrical brain structures and functioning at birth, or even before, and in early infancy. It has also been found that different stimuli seem to activate one hemisphere only, or at least one hemisphere more than the other. This is very important in infancy because the corpus callosum, the neural fibers connecting the hemispheres, are structurally and functionally incomplete until around two years of age. This means that during this early period, activation of one hemisphere does not lead to activation of the other, as it may with adults. Since activation is an important factor in brain development, and adult studies have shown that two fully developed and utilized hemispheres are necessary for optimum functioning, it seems that the best environment to stimulate infant brain development is one that activates both sides of the brain. Since very little is currently known about the relationship between different stimuli and hemispheric activation, the message seems to be that infants need to be exposed to as wide a variety of stimulation as possible in these critical first two years of development.

Brain Lateralization in Infancy: Implications for Development

We now know that most adult brains have two very differently functioning hemispheres (Dimond, 1972; Dimond & Beaumont, 1974; Kinsbourne, 1978; Kinsbourne & Smith, 1974; Ornstein, 1977; Segalowitz & Gruber, 1977). Whether this is the result of an innate predisposition or environmental influence has been a controversial issue for years and still is to some degree. Accumulating evidence seems to support the view, however, that most human brains have an innate predisposition towards lateralization of functions, but that environmental factors influence the actualization of this potential (Witelson, 1977). If this is the case, what implications does it have for the critical developmental period of infancy? How can healthy brain development be enhanced from the very beginning?

Evidence that hemispheric asymmetry is present at birth comes from several sources. One such source is the physical structure of the brain. The human infant is born with or develops very soon after birth a larger area in the left hemisphere in a region known to be of significance for language development (Witelson & Pallie, 1973), and, in fact, this anatomical asymmetry has been observed in neonates as early as the 29th gestational week (Wada, Clark, & Hamm, 1975).

Newborns have also been observed to turn their heads spontaneously to the right four times as often as to the left, and to be far more responsive to tactile, auditory, and visual stimuli presented at their right than at their left side, all of which seem to indicate an initial cerebral asymmetry (Turkewitz, Gordon, & Birch, 1965; Turkewitz, Moreau, Birch, & Crystal, 1967; Turkewitz, Moreau, Davis, & Birch, 1969).

Another source of information on infant lateralization comes from studies on hand preference, although these have not yielded consistent findings, with some showing an early left hand preference, some an early right hand preference, and some no preference at all (Young, 1977). There is some evidence, however, that although both hands are used for reaching in early infancy, they may be used for different purposes. For instance, in three-month-olds, there is a definite right hand superiority for length-of-time in grasping (Caplan & Kinsbourne, 1976), and in 17- to 40-week-olds, the left hand appears to be devoted to a kind of localizing function while the right hand is devoted to a kind of handling function (Bresson, Maury, Pieraut-Le Bonniec, & de Schonen, 1977).

Visual and auditory stimuli also produce lateralized responses in infants. Using bilateral EEG recordings, it has been found that with full-term newborns there is more right hemisphere activation for rhythmic visual stimuli (Crowell, Jones, Kapuniai, & Nakagawa, 1973), and, similarly, five-week-olds show more right hemisphere activation for brief flashes

of light (Davis & Wada, 1977). For auditory stimuli, again using bilateral EEG recordings, a consistent pattern of left hemisphere activation for speech and right hemisphere activation for musical stimuli and noise has been found with infants from one week to ten months of age (Entus, 1977; Gardiner, Schulman, & Walter, 1973; Molfese, 1977).

All of these findings seem to indicate lateral differences in hemispheric functioning from birth, or even before. The findings of left hemisphere activation for speech, however, may be the most surprising and meaningful. Can one's brain be specialized for something before it can be performed? It appears so and, in fact, this is quite characteristic of infant development in other respects. As for the brain, it seems that there is a predisposition for one hemisphere to be more activated than the other by a particular stimulus type. And that hemisphere will show this material-specific activation long before its neuronal structure is sufficiently developed for the actual behavior (Kinsbourne & Hiscock, 1977). So when speech, or some other left hemisphere preferred stimulus occurs an infant's left hemisphere is activated, while music, or some other right hemisphere preferred stimulus activates an infant's right hemisphere. And this activation is very important. Development of brain function and perhaps brain structure is a function of three factors: genetic predispositions; chemical interactions, due to factors such as nutrition and hormonal levels; and experience or use (duBois, 1976; Harris, 1978;

Wiesel, 1976). It is this third factor that we are addressing here. Early activation of the brain may be very important for brain development, and there appear to be hemispheric differences in activation which may lead to different patterns of development.

With an adult brain, it is very difficult not to activate both hemispheres, as they communicate with each other through the bundle of neural fibers connecting them, called the corpus callosum. This, incidentally, is one reason why it is so difficult to measure hemispheric specialization in normal adults. When one adult hemisphere is activated it, in turn, at least partially activates the other. This is not so, however, with infants. At birth, the corpus callosum is structurally and functionally incomplete, and communication between the hemispheres does not begin until around two years of age (Gazzaniga, 1970; Hewitt, 1962; Yakolev & Lecours, 1967). This means that in infancy, a hemisphere is activated only when exposed to an appropriate stimulus.

It has been found that optimum brain functioning is the result of the development and efficient use of both hemispheres and an interhemispheric communication system. This hemispheric symmetry has been credited with optimal cognitive functioning (Fischer & Rhead, 1974) and memory (Zaidel & Sperry, 1974), increased creativity (Bogen & Bogen, 1969; Coulter, Note 1; Whisenant & Murphy, Note 2), formal operational thinking (Brooks, 1979; Kraft, 1976), and even self-actualization (Samples, 1975) and mental health (Galin, 1974).

The development of this kind of hemispheric symmetry may begin in infancy. An optimal environment for infant brain development, then, is one that activates both sides of the brain. This means, for example, that an infant needs to be exposed to music as well as speech. Since so little is known about the relationship between types of stimuli and hemispheric activation, however, the message at this point would seem to be that infants need to be exposed to as wide a variety of stimuli as possible. This idea has been expressed by others for a variety of reasons, but now we have convincing neurological evidence to support it. Infant stimulation is important. A variety of stimulation may also be important, however, for optimum brain development and, consequently, the development of healthy, fully-functioning adults.

Reference Notes

1. Coulter, D. J. The other side of learning. Unpublished manuscript, University of Northern Colorado, 1978.
2. Whisenant, W. F., & Murphy, P. J. Bilateral EEG biofeedback and creativity. Unpublished manuscript, 1978. (Available from William F. Whisenant, VA Hospital, Providence, Rhode Island, 02908)

References

Bogen, J. E., & Bogen, G. M. The other side of the brain III: the corpus callosum and creativity. Bulletin of the Los Angeles Neurological Societies, 1969, 34, 191-220.

Bresson, F., Maury, L., Pieraut-Le Bonniec, G., & de Schonen, S. Organization and lateralization of reaching in infants: an instance of asymmetric functions in hands collaboration. Neuropsychologia, 1977, 15, 311-320.

Brooks, R. The relationship between Piagetian cognitive development and cerebral cognitive asymmetry. Greeley, Co.: University of Northern Colorado, 1979. (ERIC Document Reproduction Service No. ED 160 224)

Caplan, P., & Kinsbourne, M. Baby drops the rattle: asymmetry of duration of grasp by infants. Child Development, 1976, 47, 532-534.

Crowell, D. H., Jones, R. H., Kapuniai, L. E., & Nakagawa, J. K. Unilateral cortical activity in newborn humans: an early index of cerebral dominance? Science, 1973, 180, 205-208.

Davis, A. E., & Wada, J. A. Hemispheric asymmetries in human infants: spectral analysis of flash and click evoked potentials. Brain and Language, 1977, 4, 23-31.

Dimond, S. The double brain. Baltimore: Williams & Wilkins, 1972.

Dimond, S. J., & Beaumont, J. G. Hemisphere function in the human brain. New York: Wiley & Sons, 1974.

duBois, R. Biological individuality. In Readings in human development 1976/1977: annual editions. Guilford, Conn.: Dushkin Publishing Group, 1976.

Entus, A. K. Hemispheric asymmetry in processing of dichotically presented speech and nonspeech stimuli by infants. In S. J. Segalowitz & F. A. Gruber (Eds.), Language development and neurological theory. New York: Academic Press, 1977.

Fischer, R., & Rhead, J. The logical and the intuitive. Main Currents in Modern Thought, 1974, 31, 50-54.

Galin, D. Implications for psychiatry of left and right cerebral specialization. Archives of General Psychiatry, 1974, 31, 572-583.

Gardiner, M., Schulman, C., & Walter, D. Facultative EEG asymmetries in babies and adults. UCLA BIS Report #34, 1973, 34-40.

Gazzaniga, M. S. Cerebral dominance viewed as a decision system. In S. J. Dimond & J. G. Beaumont (Eds.), Hemisphere function in the human brain. New York: Wiley & Sons, 1974.

Harris, L. J. Sex differences in spatial ability: possible environmental, genetic, & neurological factors. In M. Kinsbourne (Ed.), Asymmetrical function of the brain. New York: Cambridge University Press, 1978.

Hewitt, W. The development of the corpus callosum. Journal of Anatomy, 1962, 96, 355-358.

Kinsbourne, M. (Ed.). Asymmetrical function of the brain. New York: Cambridge University Press, 1978.

Kinsbourne, M., & Hiscock, M. Does cerebral dominance develop? In S. J. Segalowitz & F. A. Gruber (Eds.), Language development and neurological theory. New York: Academic Press, 1977.

Kinsbourne, M., & Smith, W. L. (Ed.). Hemispheric disconnection and cerebral function. Springfield: Charles C. Thomas, 1974.

Kraft, R. An EEG study: hemispheric brain functioning of 6 to 8 year old children during Piagetian and curriculum tasks with variation in presentation mode. Columbus, Ohio: Ohio State University, 1976. (ERIC Document Reproduction Service No. ED 137 070)

Molfese, D. L. Infant cerebral asymmetry. In S. J. Segalowitz & F. A. Gruber (Eds.), Language development and neurological theory. New York: Academic Press, 1977.

Ornstein, R. E. The psychology of consciousness (2nd ed.). New York: Harcourt, Brace, Jovanovich, 1977.

Samples, R. The intuitive mode: completing the educational process. Media and Methods, 1975, 11, 24-27.

Segalowitz, S. J., & Gruber, F. A. (Eds.). Language development and neurological theory. New York: Academic Press, 1977.

Turkewitz, G., Gordon, E. W., & Birch, H. G. Head turning in the human neonate: effect of prandial condition and lateral preference. Journal of Comparative and Physiological

Psychology, 1965, 59, 189-192.

Turkewitz, G., Moreau, T., Birch, H. G., & Crystal, D. Relationship between prior head position and lateral differences in responsiveness in the human neonate. Journal of Experimental Child Psychology, 1967, 5, 548-561.

Turkewitz, G., Moreau, T., Davis, L., & Birch, H. G. Factors affecting lateral differentiation in the human newborn. Journal of Experimental Child Psychology, 1969, 8, 483-493.

Wada, J. A., Clark, R., & Hamm, A. Cerebral hemsipheric asymmetry in humans. Archives of Neurology, 1975, 32, 239-246.

Wiesel, T. N. The development of the nervous system: genetic and environmental. In Summaries of Symposia (BIS Conference Report #43). UCLA, Brain Information Service, 1976.

Witelson, S. F. Early hemisphere specialization and inter-hemisphere plasticity: an empirical and theoretical review. In S. J. Segalowitz & F. A. Gruber (Eds.), Language development and neurological theory. New York: Academic Press, 1977.

Witelson, S. F., & Pallie, W. Left hemisphere specialization for language in the newborn. Brain, 1973, 96, 641-646.

Yakolev, P. I., & Lecours, A. R. The myeolgenetic cycles of regional maturation in the brain. In A. Minkowski (Ed.), Regional development of the brain in early life. Oxford: Blackwell, 1967.

Young, G. Manual specialization in infancy: implications for lateralization of brain function. In S. J. Segalowitz & F. A. Gruber (Eds.), Language development and neurological

theory. New York: Academic Press, 1977.

Zaidel, D., & Sperry, R. W. Memory impairment after commissurotomy in man. Brain, 1974, 97, 263-272.